REMARKS/ARGUMENTS

Reconsideration of the application is requested.

Claims 1-5, 10-24, and 26-31 remain in the application. Claims 1, 20, 24, and 27 have been amended. Claims 6-9 and 25 have been cancelled.

In item 4 on pages 2-10 of the above-mentioned Office action, claims 1-5, 8-21, 23-26, and 28-31 have been rejected as being unpatentable over Chuang et al. (US Pat. No. 6,137,570) in view of the applicant's admitted prior art, further in view of Kallioniemi et al. ("Optical scatterometry of subwavelength diffraction gratings: neural-network approach," Applied Optics, vol. 37, No. 25, September 1, 1998, pp. 5830-5835) and further in view of Alumot et al. (US 5,982,921) under 35 U.S.C. § 103(a).

In item 5 on pages 10-11 of the above-mentioned Office action, claims 22 and 27 have been rejected as being unpatentable over Chuang et al. in view of the applicant's admitted prior art, further in view of Kallioniemi et al., further in view of Alumot et al. and further in view of McNeil et al. (US 5,703,692) under 35 U.S.C. § 103(a).

The rejections have been noted and claims 1 and 20 have been amended in an effort to even more clearly define the invention of the instant application. Support for the changes is found in original claims 8-9, 24, and 27.

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful.

Claim 1 calls for, inter alia:

> generating reference signatures of structured surfaces by measuring varying at least a wavelength and a polarization of an electromagnetic radiation, the polarization of the electromagnetic radiation being varied by a rotation apparatus rotating an electromagnetic radiation source, the images being selected from the group consisting of diffraction images and scattered light images of a plurality of individual structures of surfaces of production prototypes having a specified quality;
>
> providing at least one of a neural network and a fuzzy logic having a learning capability by adjusting a weighting of the at least one of the neural network and the fuzzy logic as a function of the reference signatures;
>
> measuring at least one signature of a test specimen surface to be monitored by simultaneously registering a plurality of individual structures of the test specimen surface to be monitored by using an intensity distribution of images varying at least a wavelength and a polarization of an electromagnetic radiation, the polarization of the electromagnetic radiation being varied by a rotation apparatus rotating an electromagnetic radiation source, the images being selected from the group consisting of diffraction images and scattered light images for providing a measured signature;

performing measurements for both the reference signatures and the at least one signature of the test specimen surface to be monitored one at a time;

comparing the measured signature with the reference signatures for providing comparison results by using at least one of the fuzzy logic and the neural network to evaluate similarity between the reference signatures and the measured signature; and

if a similarity between the reference signatures and measured signature has been found in the comparison step, then performing the step of:

classifying parameters of the test specimen surface based on the comparison results;

or otherwise performing the steps of:

measuring individual structures of the test specimen surface with a high resolution measuring device for providing absolute quantities of the individual structures on the surface with high resolution and for providing a further reference signature; and

adjusting the weighting of at least one of the fuzzy logic and the neural network as a function of the further reference signature;

classifying parameters of the test specimen surface based on the measurement of the individual structures.

Claim 20 calls for, inter alia:

a reference signature apparatus for providing reference signatures of structured surfaces, said reference signature apparatus being configured for performing a measurement of reference signatures by measuring an intensity distribution of images varying at least a wavelength and a polarization of an electromagnetic radiation, the images being selected from the group consisting of diffraction images and scattered light images of a plurality of individual structures of a surface of production prototypes having a specified quality;

an apparatus for providing at least one of a neural network and a fuzzy logic having a learning capability by adjusting a weighting of the at least one of the neural network and the fuzzy logic as a function of the reference signatures;

a measuring apparatus operatively connected to said reference signature apparatus, said measuring apparatus measuring at least one signature associated with a test specimen surface to be monitored by simultaneously registering a plurality of individual structures of the test specimen surface to be monitored by using an intensity distribution of images varying at least a wavelength and a polarization of an electromagnetic radiation, the images being selected from the group consisting of diffraction images and scattered light images for providing a measured signature, measurements for both the reference signatures and the at least one signature of the test specimen surface to be monitored being performed one at a time;

a rotation apparatus for varying the polarization of the electromagnetic radiation by rotating an electromagnetic radiation source;

a comparison module operatively connected to said measuring apparatus, said comparison module comparing the measured signature with the reference signatures and providing comparison results by using at least one of the fuzzy logic and the neural network to evaluate similarity between the reference signatures and the measured signature;

a classification module operatively connected to said comparison module; and

a high-resolution measuring device for measuring individual structures of the test specimen surface for providing absolute quantities of the individual structures on the surface with high resolution and for providing a further reference signature, the weighting of the at least one of the neural-network and the fuzzy logic being adjusted as a function of the further reference signature;

said classification module classifying parameters of the test specimen surface based on the comparison results, if a similarity between the reference signatures and measured signature has been found in the comparison step,

otherwise classifying parameters of the test specimen surface based on the measurement of the individual structures.

The Examiner has stated in item 2 that Chuang et al. disclose a sensor that is able to record the diffraction pattern with a high resolution. Although in optical scatterometry the diffraction image can be recorded with high resolution, this does not necessarily mean that the measurement of the individual structures is performed with high resolution or in absolute quantities as well. Claims 1 and 20 have been amended to recite that the high resolution apparatus provides signatures by measuring absolute quantities of individual structures on the surface with high resolution (see page 16, line 24 to page 17, line 17 and page 40, lines 24 to 26 of the specification).

Amended claim 1 of the instant application is now directed towards a method for monitoring a fabrication process. In a first step, a plurality of reference patterns is measured in order to provide reference signatures of structured surfaces under varying wavelength and polarization. The varying polarization is achieved by rotating the electromagnetic radiation source. The reference signatures are used for training a neural network or a fuzzy logic. Next, diffraction images or scattered light images provide a measured signature

of a test specimen under varying wavelength and polarization by rotating the electromagnetic radiation source.

The neural network or the fuzzy logic is now used to compare the measured signature with the reference signatures in order to provide a comparison result. If the comparison fails, i.e. a comparison result cannot be provided, the individual structures of the test specimen surface are measured with a measuring device, e. g. a scanning electron microscope, to provide absolute values of the device under test with high resolution. As the measurements are performed under varying wavelength and polarization one at a time, additional diffraction images are obtained which enhances the quality of the data and thus the comparison step provided by the neural network or the fuzzy logic (see page 24, line 9 to page 25, line 2 of the specification).

In Chuang et al. a method and apparatus are shown, which use far-field scattered and diffracted light to determine the quality of topological features. This is achieved by comparing the far-field diffraction data of the measurement with a base-line diffraction pattern. The base-line diffraction pattern is provided by either a comparison between different dies or regions on the same die or by calculating

the base-line pattern from a mathematical calculation (see column 14, lines 18 to 47 of Chuang et al.).

Chuang et al. do not disclose measuring with varying wavelength and polarization by rotating the electromagnetic radiation source. Furthermore, Chuang et al. fail at least to disclose a neural network for the comparison step and a measurement device providing absolute values. In this respect, the Examiner has relied on McNeil et al., Kallioniemi et al., and Alumot et al.

Kallioniemi et al. use a neural-network for an accurate quantitative characterization. Furthermore, it is mentioned in the introductory section that a neural network can be used for qualitative characterization. It is, however, not shown that the neural network can be used to evaluate similarities between reference signatures and measured signatures.

The main goal of Kallioniemi et al. is to provide absolute parameters from diffraction images, which are compared to numerically calculated images. In case it is not possible or is difficult to calculate a reference input data set, this concept cannot be applied. This is especially true for surface features with defective patterns which exhibit unexpected variations (see page 22, line 20 to page 23, line 7

of the specification of the instant application). The neural network according to Kallioniomi et al. would produce unpredictable results for surface features with defective patterns because no training has been performed for such a signature.

According to the invention of the instant application, a combination of a high resolution apparatus providing absolute values of the measured signatures with the learning capability of the neural network improves the quality of a comparison step for further measurements as the "knowledge" of the neural network improves continuously.

This concept, however, cannot be seen in Kallioniemi et al. or Chuang et al. While Kallioniemi et al. rely on calculated input data, Chuang et al. consider unmatched far-field patterns and base-line patterns as unacceptable dies (see column 13, lines 22 to 26). This information is not re-introduced as a new base-line pattern into the database. Thus, the continuously improving capabilities according to the neural network of the invention of the instant application are not shown.

According to the invention of the instant application, a re-measurement with a different measurement tool is necessary in

case the comparison step fails. For the different measurement tool, the Examiner has relied on Alumot et al.

Alumot et al. disclose an optical inspection method, wherein in a first phase the entire surface of the inspected article is examined at a relatively high speed and relatively low spatial resolution. In a second phase of optical examining, a relatively high spatial resolution with low speed is applied only for suspected locations. Both are optical measurement tools and rely on the same underlying principle of microscopy.

The concept of Alumot et al., however, is different from the concept applied by the invention of the instant application. According to the invention of the instant application, the first and the second measurements are performed with different measurement tools. The first measurements of the diffraction images or scattered light images are non-destructive. The second measurement delivers absolute measured values and is performed by, e.g., a scanning electron microscope or any other suitable measurement tool. The absolute measured values are in turn used to train the neural network. The difference is not that the resolution limits are different but that the methodologies are different.

In order to derive absolute measured values, it would otherwise be necessary to perform a detailed analysis of the diffraction pattern which is complicated and time consuming (see page 23, lines 5 to 7 of the specification of the instant application). This can be avoided by using, e.g., the scatterometer for classification of diffraction images or scattered light images and the absolute measured values for evaluation of defective parts, which exhibit unknown patterns. The capabilities and the resolution according to Alumot et al. are limited to the detection of defects on the surface of the wafer.

Furthermore, the invention of the instant application measures signatures with varying polarization and wavelength one at a time. As a result, different diffraction images are obtained which enhances the amount of information presented to the neural network and thus the quality of the comparison step without superposition of the various diffraction orders (see page 30, lines 14 to 15 of the specification).

In Chuang et al., it is not shown to provide far-field patterns with different wavelength. Chuang et al. indicate

that different polarization can be used. For the varying polarization the Examiner has relied on McNeil et al.

McNeil et al. disclose a scatterometer system, which is able to perform measurements of a sample with a detector under different polarizations. The different polarizations are achieved by rotating the sample being mounted on a sample rotary stage and by rotating the detector being mounted on a detector rotary stage.

According to the invention of the instant application, the sample is kept stationary while the electromagnetic radiation source rotates. The varying measurement conditions can be achieved by components not related to the mounting of the semiconductor wafer. This has the advantage that the method and system can be applied for in-line in-situ measurements of semiconductor products (see page 28, lines 17 to 21 of the specification). During processing, the semiconductor wafer is mounted within processing tools, which do not usually rotate. Accordingly, the method of the invention of the instant application can be performed and the device of the instant application can be used within a semiconductor processing facility. In order to arrive at a method and system for monitoring fabrication processes, a person skilled in the art would therefore not consider the teachings of McNeil et al.

In summary, the invention of the instant application provides many different unexpected and surprising results, which are not taught by the cited references.

It is accordingly believed to be clear that none of the references, whether taken alone or in any combination, either show or suggest the features of claims 1 and 20. Claims 1 and 20 are, therefore, believed to be patentable over the art and since all of the dependent claims are ultimately dependent on claims 1 or 20, they are believed to be patentable as well.

In view of the foregoing, reconsideration and allowance of claims 1-5, 10-24, and 26-31 are solicited.

In the event the Examiner should still find any of the claims to be unpatentable, counsel would appreciate a telephone call so that, if possible, patentable language can be worked out. In the alternative, the entry of the amendment is requested as it is believed to place the application in better condition for appeal, without requiring extension of the field of search.

If an extension of time for this paper is required, petition for extension is herewith made. Please charge any fees which

might be due with respect to 37 CFR Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,

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